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Commentary

Pain memory in clinical practice

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Abstract: Pain is increasingly understood not only as a sensory event but also as a cognitive and affective experience that becomes encoded, stored, and reconstructed through memory. Research on pain memory has expanded significantly in recent years, revealing considerable variability in the accuracy of recalled pain. Importantly, emerging evidence demonstrates that pain memory holds meaningful clinical implications. This commentary focuses on discussing the role of pain memory in clinical practice, with an emphasis on its clinical implications and both current and future clinical applications. The key clinical implications of pain memory involve its impact on decision-making about procedures that may cause pain, on future painful experiences, and on the likelihood of developing chronic pain. However, despite these findings, current clinical practice often relies on pain recall alone, without assessing the contemporaneous pain event. This approach introduces potential bias, given that pain memories are known to be inaccurate. Therefore, it may be important in the future to determine how pain memory can be accurately assessed and effectively used to create new opportunities for improving pain management, predicting long-term outcomes, and developing interventions that address maladaptive pain recollections. Further empirical work is essential to determine the feasibility and clinical value of integrating pain memory into routine practice.

Keywords: pain memory; clinical implications; pain recall; clinical application; pain chronicity; recall accuracy

1. Introduction

Pain is not only a sensory event but also a cognitive and affective experience that becomes encoded, stored, and later reconstructed through memory [1]. The memory of pain plays a crucial role

in shaping how individuals perceive, interpret, and respond to subsequent nociceptive events [2–5]. In recent years, the study of pain memory has drawn growing scientific attention. Much of the existing research has focused on examining the accuracy of recalled pain, an aspect that has yielded highly heterogeneous findings within the current literature [6–8]. While some investigations suggest that pain memory is relatively accurate and remains consistent over time [6], others report substantial discrepancies between the original experience and its later recollection, with tendencies both toward underestimation [7] and overestimation [8]. This divergence in empirical results likely reflects the complex and dynamic nature of pain encoding and retrieval processes, which are shaped by numerous internal and external influences [9].

As for how the pain memory works, following an acute painful episode, the initial representation of the nociceptive experience is processed by working memory before undergoing consolidation into long-term storage [10]. Consolidation is thought to occur within a window of approximately 24 h, during which the memory trace is highly malleable and susceptible to modulation [11]. Several psychological and physiological factors may alter the quality of the encoded memory during this period [9,12,13]. For instance, emotional state has been shown to influence how pain is later reconstructed, with negative affect often associated with exaggerated recollections, and positive affect linked to more attenuated memories [13]. Hormonal responses also appear to play a substantial role [12]. Situations that involve significant oxytocin release, such as childbirth or strenuous endurance exercise, have been associated with reduced pain recollection, suggesting that neurochemical changes can lead individuals to remember painful events as less intense than they were [12]. These findings highlight the extent to which pain memory does not function as a straightforward record of the past but instead reflects a reconstruction shaped by multiple interacting influences. Beyond consolidation, additional variables may exert their effects at later stages of the mnemonic process, such as during storage or retrieval. Factors including the interval between the painful event and its recall, the type and context of the original pain, age-related cognitive differences, expectations regarding pain, and the patient-practitioner interaction (for example, the placebo effect), have all been identified as potential determinants of how accurately a painful experience is remembered [13–19]. Taken together, these findings illustrate the multifaceted nature of pain memory and underscore the importance of situating it within broader cognitive and physiological frameworks.

Despite extensive research on the accuracy of pain memory and the numerous factors that influence its formation and retrieval, far less attention has been directed toward understanding its concrete implications within clinical contexts. This gap highlights the need for studies that investigate how pain memory can be applied in clinical practice.

2. Pain memory clinical implications

Three major clinical implications regarding pain memory have been identified in the literature: the influence of pain memory on later painful experiences, on decision-making involving potentially painful procedures, and on the risk of developing chronic pain [2–5]. Together, these findings underscore the importance of considering remembered pain as a target for clinical intervention.

The first clinical implication to comment on is that remembered pain can shape the intensity and trajectory of future painful experiences [2]. This effect was demonstrated empirically in a prospective study by Noel et al. (2012) [2], who examined the relationship between children's memories of pain and their subsequent nociceptive responses. In this study, 110 healthy children aged 8–12 years completed

an experimentally induced pain task and provided immediate pain ratings [2]. Two weeks later, they reported their memories of the pain and their expectations regarding future discomfort [2]. One month after the initial exposure, the children repeated the pain task and again provided pain ratings [2]. The findings revealed that recollections of pain, not the initial pain reports, were the strongest predictors of later pain responses [2]. Children who formed negatively biased pain memories developed heightened expectations of future pain and displayed increased pain ratings over time compared with children whose recollections were accurate or positively biased [2]. These results suggest that distorted pain memories can amplify later pain experiences, implying that clinicians should not only manage acute pain effectively but also strive to prevent the formation of exaggerated or negatively skewed pain memories in pediatric populations [2].

The second clinical implication to mention is that pain memory also plays a central role in shaping future decisions regarding experiences that may involve discomfort, including medical procedures [3]. An experimental study by Kahneman et al. (1993) [3] provided compelling evidence of this phenomenon using cold-pressor trials. Participants underwent two aversive immersions: a short trial consisting of 60 s at 14 °C, and a longer trial consisting of the same 60 s at 14 °C plus an additional 30 s during which the temperature gradually rose to 15 °C, a level still painful but less intense [3]. Despite the objectively longer exposure to pain, most participants later chose to repeat the long trial [3]. This counterintuitive preference was attributed to a cognitive bias in which retrospective evaluations of aversive experiences are disproportionately determined by the worst moment and the final moments of the episode, rather than by its overall duration [3]. Known as the "peak-end rule", this phenomenon has important clinical implications: patients' willingness to undergo future procedures may depend more on how the procedure ended and how it is ultimately remembered than on the contemporaneous intensity or duration of the initial pain [3,20,21].

A third major clinical implication concerns the contribution of pain memory to the development and maintenance of chronic pain, particularly following invasive medical procedures [4,5]. Two large-scale studies conducted by Tasmuth et al. (1995, 1997) [4,5] examined chronic post-treatment pain in women treated for breast cancer. Tasmuth et al. observed that one of the most significant predictors of chronic pain was the remembered intensity of acute postoperative pain [4,5]. This finding highlights the influential role of pain memory in the transition from acute to chronic pain [4,5].

3. Current clinical applications of pain memory

In the current literature, we can observe that clinical applications of pain memory are based on the use of recalled pain alone as a clinical tool, without assessing the contemporaneous pain experience. An example of this is the use of pain recall when validating health questionnaires and tools [22,23]. Nag et al. (2022) developed and validated patient-reported outcome tools for ulcerative colitis and Crohn's disease in adults with moderate-to-severe disease using the 24-h pain recall, without previously assessing the contemporaneous pain experience [22]. The same procedure was carried out by Williams-Hall et al. (2022), whose study validated a series of questionnaires in patients with lupus using 24-h and 7-day pain recalls [23].

Another example of the clinical application of pain memory using only the assessment of recalled pain is the study by Pajari et al. (2022) [24], in which 52 patients referred for surgical treatment of basal thumb joint osteoarthritis were invited to participate. All patients wore a splint for six weeks, followed by surgery. Pain during the past day, week, and month was collected at baseline, on the day

of the operation, and at 3, 6, 9, and 12 months after surgery. These pain memory measures were used to assess the effect of the treatment on pain [24].

However, this use may not be entirely optimal, given the existence of current evidence showing that pain recall can be inaccurate [7,8,25–28]. Furthermore, it is important to note that this assessment method is not common in the current literature on pain memory evaluation. Although there are studies such as Trevisan et al. (2015) [29], in which pain memory is assessed solely by measuring pain recall, much of the available evidence on pain memory is based on evaluating both the contemporaneous pain experience and its subsequent recall, either by using a single measurement of actual experience or by taking repeated measurements using an ecological momentary assessment (EMA) [30–33].

Therefore, evaluating pain recall in isolation, without measuring the contemporaneous pain experience, may not constitute a fully objective or valid measure due to the intrinsic recall bias associated with this approach, in addition to the fact that it is not commonly used in current pain memory research [7,8,25–28,30–32].

4. Future directions in the clinical application of pain memory

Regarding the potential future clinical applications of pain memory, the first key consideration involves not only how it should be used but also the conditions under which its use would be clinically meaningful. As previously noted, relying solely on remembered pain without also assessing the original painful experience introduces a memory bias that ought to be avoided, particularly given the well-documented variability and susceptibility of pain memories to distortion [7,8,25–28]. These distortions may arise from emotional, cognitive, contextual, and neurobiological influences, all of which can significantly alter the accuracy of recalled pain [9,12–16]. For this reason, future clinical uses of pain memory will likely draw on approaches that focus on evaluating memory accuracy by systematically comparing the initial pain experience with its later recall. This methodological framework is currently the most common in research assessing pain memory and provides a more reliable basis for clinical interpretation, as it allows clinicians and researchers to distinguish between accurate representations of pain and biased or reconstructed memory traces that may have clinical significance [30–32].

Another important consideration for future clinical applications is the degree to which proposed uses align with the established clinical implications of pain memory. For instance, given the evidence that pain memory influences subsequent painful experiences, one possible translation into clinical practice could involve using pain memory as an indicator to assess the effectiveness of an intervention or the patient's response to a specific treatment. This step is easier to incorporate than it seems, since there are already quite a few studies on therapeutic interventions that directly or indirectly assess pain memory. Therefore, the only adjustment needed would be to include in the analysis an assessment of the relationship between the accuracy of pain memory and the effect or response to the treatment [31,32].

Moreover, considering the clinical implication of pain memory in the development and maintenance of chronic pain, another potential application may involve predicting pain chronicity by using memory accuracy as a prognostic marker. Research has shown that pain memories may be associated with pain chronification [4,5]. If this association is confirmed through future empirical work, clinicians may be able to identify individuals who are more vulnerable to transitioning from acute to chronic pain by examining whether their memories of initial painful events deviate significantly from

the original experience. Such early identification could enable timely intervention and preventive strategies, potentially reducing the long-term burden of chronic pain.

It is important to emphasize, however, that these proposals remain hypothetical. Although the theoretical rationale for these applications is compelling, empirical support is currently limited. Moreover, another important current limitation is that, due to the nature of pain memory and the diversity of epistemological approaches surrounding it, the most effective method for its assessment remains unclear, as does its precise relationship with other types of memory. Clarifying these aspects is essential to ensure that its clinical application can be implemented with the highest possible accuracy and utility. Therefore, further research and empirical evidence are needed to determine these primary aspects. Only through rigorous investigation will it be possible to clarify the true potential of pain memory and its role in advancing patient care.

5. Conclusions

In summary, the existing evidence demonstrates that pain memory is a critical yet often overlooked component of pain experience, with meaningful implications for both clinical practice and future research. The literature consistently shows that remembered pain can shape subsequent nociceptive responses, influence decision-making in situations involving potential discomfort, and contribute to the transition from acute to chronic pain. These findings underscore the importance of addressing not only the immediate sensory aspects of pain but also the cognitive representations patients form after the event. Despite this, current clinical applications tend to rely on recalled pain as a standalone measure, a practice that may be insufficient given the well-documented variability and potential inaccuracy of pain memory. This highlights a clear need for methodological refinement, particularly through approaches that systematically compare initial pain experiences with their subsequent recall. Such strategies may provide a more objective and clinically meaningful understanding of pain memory. Looking forward, the potential integration of pain memory into clinical practice, whether for evaluating treatment effectiveness, guiding patient decision-making, or predicting pain chronicity, remains promising but largely theoretical. Continued empirical investigation, supported by rigorous longitudinal designs and standardized protocols, will be essential to determine whether pain memory can reliably inform clinical assessment and ultimately enhance patient outcomes.

Author contributions

CFA: Conceptualization; Writing - original draft; Writing - review & editing. FCM: Writing - review & editing.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

Ferran Cuenca-Martínez is the guest editors for special issue of AIMS Medical Science and was not involved in the editorial review or the decision to publish this article. All authors declare that there are no competing interests.

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